

**Injuries in Professional Australian Soccer;
a League-Based Analysis of Injury Trends, Influences
and Infrastructure.**

By

Donna Lu

Bachelor of Human Movement (Honours)

A thesis completed in fulfilment of the requirements of the degree of
Doctor of Philosophy

8 July 2020

Certificate of Authorship and Originality of Thesis

I, Donna Lu, declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

Production Note:
Signature removed prior to publication.

Donna Lu

08/07/2020

Date Submitted

Acknowledgements

To begin with, I would like to thank Professor Rob Duffield supervising me the past 5 years. Your unwavering support and devotion of time to me has not only helped me produce this thesis, but you have helped me grow into a person I can be happy and confident with. You're RAD!

To Dr Alan McCall, thank you for all your help throughout this process. Your knowledge and experience have been unfathomable to this thesis and my development in the field.

Thank you, Dr Mark Jones, for your time and trust. I would not have been able to achieve all that I have at FFA without your support. In a male dominant industry, you make me hopeful that my gender will not limit me.

I want to thank FFA, everyone who works in the Leagues and all of the physiotherapist I've worked closely with these past couple of years. This thesis would not exist without you and all your efforts!

I would like to thank my family – my mum, dad and brother. You have all sacrificed time, money and a whole of stress for me to get here. You are the people who believed in the most when I didn't believe in myself. I hope this accomplishment makes you proud. From the small streets of Western Sydney to the rest of the big world, it has been an absolute journey. Also, thank you to my favourite boy, Rocky! You're always by myside and know exactly how to cheer my up. 13/10 good boy.

To the rest of the extended family, having you all cheer me on has made this journey much easier and worth it.

To my best friend, Xinh, no matter where we find ourselves, I know I can always count on you. I am so grateful to have you keep me grounded.

To the UTS SES crew and Elaine, going day in and day out has not been easy but at least it was a whole lot of fun because of you all.

A special thank you to Dr Job Fransen for your patience and teaching me stats. I cannot thank you enough. It's been an emotional ride, but you always know how to lighten the mood.

Another special thanks to Associate Professor Mark Watsford, for inconspicuously stepping in as a mentor when I didn't have anyone to go to!

Thank you!

Table of Contents

Certificate of Authorship and Originality of Thesis	i
Acknowledgements.....	ii
Table of Contents	iv
List of Tables	vii
List of Figures.....	ix
Abbreviations Symbols and Subunits	x
Publications Resulting From this Thesis.....	xi
Abstract.....	xii
 Chapter 1 : Introduction	 1
1.1 Introduction.....	2
1.2 Injuries in professional soccer.....	5
1.3 The impact of soccer injuries	7
1.4 Provision and infrastructure of soccer player care.....	8
1.5 Thesis Aims.....	9
1.6 Significance of Thesis	10
1.6 Limitations	11
1.7 Delimitations	12
 Chapter 2 : Literature Review	 14
2.1 Overview	15
2.2 Literature Review Methods.....	15
2.3 The Professional Australian Soccer League	18
2.4 Operational Definitions	25
2.5 Injury Epidemiology and Methodological Issues	27
2.5.1 <i>Injury definition and calculation of injury incidence</i>	<i>27</i>
2.5.2 <i>Taxonomy of injury characteristics</i>	<i>32</i>
2.5.3 <i>Understanding Soccer Injury Epidemiology</i>	<i>42</i>
2.6 The Cost of Professional Soccer Injuries	44
2.6.1 <i>Salary cost of injury in soccer.....</i>	<i>44</i>
2.6.2 <i>Effects of professional soccer injuries on team performance</i>	<i>45</i>
2.7 Provision and Infrastructure for Athlete Care in Professional Soccer	47
2.8 Theoretical Frameworks of Injury Prevention: an organisational perspective.	51
2.8.1 <i>Injury prevention frameworks</i>	<i>51</i>
2.8.2 <i>Injury prevention from an organisational perspective.....</i>	<i>57</i>

2.9 State of the Literature.....	60
Chapter 3 : Study 1	62
Injury epidemiology in Australian male professional soccer.....	62
3.1 Abstract	63
3.2 Introduction	64
3.3 Methods.....	66
3.4 Results	68
3.5 Discussion	76
3.6 Conclusion	80
Chapter 4 : Study 2	82
Variability of team-level injury underlying league-level injury rates in a professional soccer league	82
4.1 Abstract	83
4.2 Introduction	84
4.3 Methods.....	86
4.4 Results	88
4.5 Discussion	93
4.6 Conclusion	97
Chapter 5 : Study 3	98
The Financial and Performance Cost of Injuries to Teams in Australian Professional Soccer.....	98
5.1 Abstract	99
5.2 Introduction	100
5.3 Methods.....	102
5.4 Results	105
5.5 Discussion	110
5.6 Conclusion	114
Chapter 6 : Study 4	115
The provision and infrastructure of medical care in professional Australian Professional Soccer Clubs.	115
6.1 Abstract	116
6.2 Introduction	117
6.3 Methods.....	119

6.4 Results	122
6.5 Discussion	129
6.6 Conclusion	134
Chapter 7 : Discussion	136
7.1 Introduction	137
7.2 Injury epidemiology of Australian professional soccer players.....	138
7.2.1 League- and team-level injury rate and trends	138
7.2.2 Type and Location injury rate and trends	140
7.2.3 Circumstances of injury occurrence.....	143
7.3 The impact of injuries on Australian professional soccer	147
7.3.1 Financial repercussions of injury.....	147
7.3.2 Performance repercussions of injury	148
7.4 Provision and infrastructure of athlete care in professional Australian soccer	149
7.4.1 Experience and qualifications over time in the A-League.....	149
7.4.2 Appointment and time demands over time in the A-League	151
7.4.3 Services over time in the A-League	153
7.5 The state of affairs of injury in Australian soccer	154
7.6 Limitations	158
Chapter 8 : Summary, Practical Applications and Future Directions.....	161
8.1 Thesis aims.....	162
8.2 Key findings	163
8.3 Practical applications	165
8.4 Future Research.....	166
Chapter 9 : References	167
Appendices	192
<i>Appendix A – Ethics Approval</i>	<i>193</i>

List of Tables

Table 1.1. List of A-League licenced Clubs, their locations and the seasons competed in the A-League (✓).....	4
Table 2.1. Changes in the A-League Minimum Medical Standards.	22
Table 2.2. Definitions of injury used in this document (Fuller et al. 2006).....	26
Table 2.3. Injury Incidence of multi-team professional soccer injury epidemiology.	30
Table 2.4. Count and proportion (%) of injuries across injury regions in domestic professional soccer leagues.	36
Table 2.5. Count and proportion (%) of injury type in professional soccer leagues.	38
Table 2.6. Injury incidence in each severity group in professional soccer players.....	41
Table 3.1. Injury count (n), percentage distribution (%), injury rate (95%CI) and rate ratio (RR) by type per season.	73
Table 3.2. Injury count (n), percentage distribution (%), injury rate (95%CI) and rate ratio (RR) by type per season.	75
Table 4.1. Interclass correlation coefficient (ICC) and Coefficient of Variation (CV) reported for overall injury rates, injury rates by type and injury rates by location.....	90
Table 4.2. Likelihood Ratio Test comparing full models estimating the overall-,individual type-, and individual location-injury rates over 6 seasons and comparison of marginal (R2m) to conditional (R2c) R-squared.....	91
Table 4.3. Back-transformed coefficients from significant generalised linear mixed models identified from likelihood ratio tests.	92

Table 5.1. Profile of injuries per team per season, injury rate ratio, missed matches per team per season and total league salary cap between 2012/13 to 2017/18 used to calculate a financial cost.	107
Table 5.2. Retained models that explain the effect of team performance on injury count and count of missed matches.	108
Table 5.3. Back-transformed coefficients, 95% confidence intervals (CI), standard errors and random effects parameters from the 2 final generalised linear mixed models investigating the likelihood of team performance variable are associated with less injuries. Coefficients shown have been back-transformed.	109
Table 6.1. Mean \pm SD length of tenure, proportion (%) of undergraduate compared to postgraduate qualifications and percentage (%) of those who had Other Sport Experiences in Head Physiotherapists of each A-league club.	124
Table 6.2. Number of professionals appointed (n) and their time commitments (h) within each A-League medical department in four seasons between 2010/11 and 2016/17.	125
Table 6.3. Frequency of teams (n) and proportion (%) that completed injury prevention as a whole squad, in subgroups or individuals in four seasons of the A-league between 2010/11 and 2016/17.....	127
Table 6.4. Frequency (n) and percentage (%) of teams who conduct musculoskeletal screening in four seasons of the A-League between 2010/11 and 2016/17.....	128

List of Figures

Figure 2.1. Schematic outline of literature search process and exclusion criteria for the current literature review (Moher et al. 2009).	17
Figure 2.2. Sequence of Prevention (van Mechelen, Hlobil & Kemper 1992).	54
Figure 2.3. Translational Research into Injury Prevention Practice framework (Finch 2006).	55
Figure 2.4. The Team-sport Injury Prevention (TIP) cycle (O'Brien et al. 2019).	56
Figure 3.1. Injury trends between season 2012/13 and 2016/17 for A) Total injuries, B) Injuries by Setting, C) injury by mechanism; and, D) injury incidence by severity group.	71

Abbreviations Symbols and Subunits

Symbol/Abbreviations	Word/Phrase
A-League	Australian League
FFA	Football Federation Australia
AFC	Asian Football Confederation
FIFA	Fédération Internationale de Football Association
UEFA	Union of European Football Associations
CONACACAF	Confederation of North, Central America and Caribbean Association Football
CONMEBOL	South American Football Confederation
CAF	Confederation of African Football
OFC	Oceania
F-MARC	FIFA Medical and Research Centre
PFA	Professional Footballers Australia
CBA	Collective Bargaining Agreement
MMS	Minimum Medical Standards
OSICS	Orchard Sports Injury Classification System
SMDCS	Sports Medicine Diagnostic Coding System
GPS	Global Positioning System
GLM	General Linear Model
GLMM	Generalised Linear Mixed Model
RR	Rate Ratio
ICC	Intraclass Correlation
CV	Coefficient of Variation
CI	Confidence Interval
h	Hour/s
=	Equals
≈	Approximately equal
+	plus
±	Plus or minus
%	Percent
α	Alpha
β	Beta
χ^2	Chi-Squared

Publications Resulting From this Thesis

Lu, D., McCall, A., Jones, M., Kovalchik, S., Steinweg, J., Gelis, L., & Duffield, R. (2020). Injury epidemiology in Australian male professional soccer. *Journal of Science and Medicine in Sport*. <https://doi.org/10.1016/j.jsams.2020.01.006>

In review

Lu, D., McCall, A., Jones, M., Steinweg, J., Gelis, L., Fransen, J. & Duffield, R. The Financial and Performance Cost of Injuries to Teams in Australian Professional Soccer. *Journal of Science and Medicine in Sport*

To be submitted

Lu, D., McCall, A., Jones, M., & Duffield, R. Variability of team-level injury underlying league-level injury rates in a professional soccer league. *Currently reviewed by the Legal Department of Football Federation Australia*

Lu, D., McCall, A., Jones, M., Steinweg, J., Gelis, L. & Duffield, R. The provision and infrastructure of medical care in professional Australian Professional Soccer Clubs. *Currently reviewed by the Legal Department of Football Federation Australia.*

Abstract

This thesis examines injury epidemiology, the impact of those injuries and the context of the injury epidemiology in the Australian professional soccer (association football) league (the A-League). To do this, data on injury, player-salary, team performance and provision and infrastructure of athlete care were collected from all A-League teams between seasons 2012/13 to 2017/18. The event of an injury and the characteristics were collected via a standardised injury surveillance system. For Study 1, the injury data was aggregated as a league and then by injury characteristics i.e. setting, mechanism, type and location. Generalised linear models (GLM) were used to model the data against seasons to report injury incidence rates (per 27 rounds) and trends over time. For Study 2, the injury data was aggregated by teams, and generalised linear mixed models (GLMM) were used to model the data against seasons to report injury incidence rates (per 27 rounds) and trends. Further, this analysis considered variations in team injury rates within a season and differences between teams across multiple seasons. For Study 3, the injury data was paired with player-salary and team performance costs of injury which were collated from confidential and publicly available data. Again, a GLM was used to analyse the trend of player-salary cost of A-League injuries and whilst a GLMM was used to assess the association between injury and team performance variables. For Study 4, the injury data was contextualised through a survey study where the head physiotherapist of each A-League team was asked to outline the provision and infrastructure of athlete care within the A-League.

The key findings from these studies were:

Study 1:

- The league-level (A-League) injury incidence rate ranged from 4.8 (95%CI:4.1–5.8) to 6.7 (95%CI:5.8–7.8) injuries per round per season and there were no significant differences between season 2012/13 to 2017/18 ($p < 0.05$).
- Thigh injuries (23–36%), particularly hamstring injuries (54%–65%), were most common, with muscle/tendon injuries the most common type (50–60% of total injuries/season). There were no significant differences between seasons within each injury type or location ($p > 0.05$ and $p > 0.05$, respectively).
- Regarding the setting of which injuries occur, training injuries decreased across the 6 seasons ($\exp(\beta)$ 0.59[95%CI:0.36–1.0]; $p = 0.04$).
- Although there was a higher proportion of non-contact injuries, both contact and non-contact injuries were not significantly different across the 6 seasons ($p > 0.05$).
- Mild severity injuries decreased ($\exp(\beta)$ 0.64 [95%CI:0.4–0.9]; $p = 0.02$), whilst moderate severity injuries increased ($\exp(\beta)$ 1.7 [95%CI:1.0–2.8]; $p = 0.04$) in season 2017/18 compared to 2012/13. Severe injuries remained stable across the 6 seasons ($p > 0.05$).

Study 2:

- Low variance (mean \pm standard deviation = 34.1% \pm 21.7) and poor to moderate reliability of between-season injury rate (ICC=0.319-0.831) supports the consistent stable injury trends at the league- and team-level injury rate.
- Team-level injury incidence rate ranged from 12.1 (10.1-14.5) to 18.2 (15.7-21.0) injuries per team per season, which significantly decreased in 2015/16 compared to 2012/13 ($p=0.011$).
- Joint/ligament injury rates significantly reduced in 2015/16 ($p=0.001$), which coincides with the significant reduction of injuries in the overall team-level injury rate. The model variance showed the reduction of Joint/ligament injuries was league-wide ($R^2_m=0.23$; $R^2_c=0.23$).

Study 3:

- Total league missed matches were significantly higher in season 2013/14 (55.1[50.7-59.9]; $p<0.01$) and 2014/15 (71.4 [66.4-76.8]; $p<0.001$) compared to 2012/13, without differences between other seasons. The significantly higher missed matches in 2014/15 were concomitant to the peak of player-salary cost which ranged between AUD \$187,990 – AUD \$332,680/team ($p<0.01$).
- Higher injuries rates were associated with additional goals conceded ($p=0.007$). Similarly, sum of missed matches was associated with more conceded goals and drawn matches ($p<0.000$).

Study 4:

- There were typically 1.6-1.9 physiotherapist per team tenured for 3.1 ± 2.4 years and were postgraduate qualified (55-70%) with experience from other sports (70-91%). Additionally, there were 1.1-1.4 physicians, 1.1-1.3 massage therapists and 1.2-2.0 Exercise specialists each season ($p > 0.05$).
- The Time Demands of practitioners did not differ between seasons ($p > 0.05$), except for Exercise Specialists who increased by ≈ 30 h/week in 2015/16 compared to season 2010/11 ($p = 0.014$).
- The provision of injury prevention programs was delivered daily as a whole squad over the 4 seasons ($p > 0.05$). However, an increase in subgroup injury prevention on either a daily or several times/week existed ($\chi^2 = 0.041$; $p = 0.005$). All teams completed preseason musculoskeletal screening in all seasons.

In summary, muscle/tendon injuries at the thigh, particularly at the hamstring, are of interest for stakeholders when developing or allocating resources to injury prevention. Competition organisers and medical staff should still be aware of the variation in less common injuries, though individual injury trend analysis should address such an issue. Key findings suggest interpretation of stable league- and team-level aggregated injury rates is accurate, which is supported by the low between-season injury rate variance. Nonetheless, injury prevention programs need to continue to focus on muscle/tendon and joint/ligament injuries at the hamstring and knee.

The league-wide reduction in injury rate in 2015/16 was mirrored by a trend for reduced joint/ligament injuries. The observed reduction was league-wide rather than a single team or a group of teams, suggesting most teams had exposure to the cause of the injury reduction. Although currently speculative, league-wide injury prevention strategy, such as a league-wide physical exercise programs, education and/or policy, may be plausible explanations. Such strategies require all levels of stakeholders (i.e. Competition organiser, clubs/ team officials and players) to be involved. Of interest to competition organisers and coaches, injury and missed matches are associated with goals conceded and matches drawn, though the magnitude of the association is small.

Finally, the findings suggest that injuries are relatively stable, and infrastructure of athlete care was similar despite more recent emphasis on injury prevention in the A-League between seasons 2012/13 to 2017/18. Competition organisers and clubs should be aware that having adequate provision and infrastructure of athlete care within teams may enable better control of injury rates. However, further reductions of injury require targeted injury prevention programs to the team and the individual player.